ARMY
15.3 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The US Army Research, Development, and Engineering Command (RDECOM) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Web site: **https://www.armysbir.army.mil/.**

Solicitation, topic, and general questions regarding the SBIR Program should be addressed according to the DoD Program Solicitation, for specific questions about the Army SBIR program contact the Army SBIR helpdesk. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit https://sbir.defensebusiness.org/. Specific questions pertaining to the Army SBIR Program should be submitted to:

John Smith
Program Manager, Army SBIR
usarmy.apg.rdecom-ac.mbx.sbir-program-managers-helpdesk@mail.mil
US Army Research, Development and Engineering Command (RDECOM)
6200 Guardian Gateway
Suite 145
Aberdeen Proving Ground, MD 21005-1322
TEL: (866) 570-7247
FAX: (443) 360-4082

The Army participates in three DoD SBIR Solicitations each year. Proposals not conforming to the terms of this Solicitation will not be considered. Only Government personnel will evaluate proposals.

PHASE I PROPOSAL SUBMISSION

SBIR Phase I proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes) and any other attachments. Small businesses submitting a Phase I Proposal must use the DoD SBIR electronic proposal submission system **(https://sbir.defensebusiness.org/).** This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

The small business will also need to register at the Army SBIR website **https://www.armysbir.army.mil/** in order to receive information regarding proposal status/debriefings, summary reports, impact/transition stories, and Phase III plans.

Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 20-page limit.

Only the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool. **Army Phase I proposals submitted containing a Technical Volume over 20 pages will be deemed NON-COMPLIANT and will not be evaluated. It is the responsibility of the Small Business to ensure that once the proposal is submitted and uploaded into the system it complies to the 20 page limit.**

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DoD Program Solicitation.

15.3 Phase I Key Dates	
Solicitation closes, proposals due	28 Oct 2015
Phase I Evaluations	30 Oct – 04 Jan 2016
Phase I Selections	05 Jan 2016
Phase I Award Goal	29 Feb 2016

**Subject to the Congressional Budget process*

PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL

The Army implements the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal.

PHASE I COST VOLUME

A firm fixed price or cost plus fixed fee Phase I Cost Volume ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete Phase I Cost Volume not to exceed a maximum dollar amount of $100,000 and six months and a Phase I Option Cost Volume not to exceed a maximum dollar amount of $50,000 and four months. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Volume. The Cost Volume DOES NOT count toward the 20-page Phase I proposal limitation. When submitting the Cost Volume, complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal.

PHASE II PROPOSAL SUBMISSION

Commencing with Phase II's resulting from a 13.1 Phase I, invitations are no longer required. Small businesses submitting a Phase II Proposal must use the DoD SBIR electronic proposal submission system **(https://sbir.defensebusiness.org/).** This site contains step-by-step instructions for the preparation and submission of the Proposal Cover Sheet, the Company Commercialization

Report, the Cost Volume, and how to upload the Technical Volume. For general inquiries or problems with proposal electronic submission, contact the DoD SBIR Help Desk at 1-800-348-0787 (9:00 a.m. to 6:00 p.m. ET).

A single Phase II proposal can be submitted by a Phase I awardee only within one, and only one, of four submission cycles shown below and must be submitted between 4 to 17 months after the Phase I contract award date. Any proposals that are not submitted within these four submission cycles and before 4 months or after 17 months from the contract award will not be evaluated. Any follow-on Phase II proposal (i.e., a second Phase II subsequent to the initial Phase II effort) shall be initiated by the Government Technical Point of Contact for the initial Phase II effort and must be approved by Army SBIR PM in advance.

SUBMISSION CYCLES	TIMEFRAME
Cycle One	30 calendar days starting on or about 15 October*
Cycle Two	30 calendar days starting on or about 1 March*
Cycle Three	30 calendar days starting on or about 15 June*
Cycle Four	30 calendar days starting on or about 1 August*

*Submission cycles will open on the date listed unless it falls on a weekend or a Federal Holiday. In those cases, it will open on the next available business day.

Army SBIR Phase II Proposals have four Volumes: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 38-page limit including: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents (e.g., statements of work and resumes), data assertions and any attachments. Do not include blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in other sections of the proposal as these will count toward the 38 page limit. As with Phase I proposals, it is the proposing firm's responsibility to verify that the Technical Volume does not exceed the page limit after upload to the DoD SBIR/STTR Submission site by clicking on the "Verify Technical Volume" icon.

Only the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 38-page limit. The CCR is generated by the proposal submission website, based on information provided by you through the Company Commercialization Report tool.

Army Phase II Proposals submitted containing a Technical Volume over 38 pages will be deemed NON-COMPLIANT and will not be evaluated.

Army Phase II Cost Volumes must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of $1,000,000. During contract negotiation, the contracting officer may require a Cost Volume for a base year and an option year. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Small businesses submitting a proposal are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal.

DoD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DoD Program Solicitation very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the solicitation.

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.5 of this solicitation for definitions of “lawful permanent resident” and “protected individual”] as key personnel, they must be clearly identified. **For foreign nationals, you must provide country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Please ensure no Privacy Act information is included in this submittal.**

OZONE CHEMICALS

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase I ($100,000 maximum), Phase I Option ($50,000 maximum), and Phase II ($1,000,000 maximum), under “CMRA Compliance” in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://cmra.army.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

    (1) Contract number, including task and delivery order number;
    (2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
    (3) Estimated direct labor hours (including sub-contractors);
    (4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
    (5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
    (6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
    (7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

DISCRETIONARY TECHNICAL ASSISTANCE

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed nine Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

For more information go to: https://www.armysbir.army.mil, then click the "SBIR" tab and then click on Transition Assistance/Technical Assistance.

As noted in Section 4.22 of this solicitation, firms may request technical assistance from sources other than those provided by the Army. All such requests must be made in accordance with the instructions in Section 4.22. It should also be noted that if approved for discretionary technical assistance from an outside source, the firm will not be eligible for the Army's Technical Assistance Advocate support.

COMMERCIALIZATION READINESS PROGRAM (CRP)

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DoD and/or non-DoD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at https://portal.armysbir.army.mil/Portal/SmallBusinessPortal/Default.aspx and is due within 30 days of the contract end date.

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) Submit two copies of the approved scientific or technical report delivered under the contract to the

Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

ARMY SBIR PROGRAM COORDINATORS (PC) and Army SBIR 15.3 Topic Index

Participating Organizations	PC	Phone
Aviation and Missile RD&E Center (AMRDEC-A) (AMRDEC-M)	Dawn Gratz	256-842-8769
Armaments RD&E Center (ARDEC)	Benjamin Call	973-724-6275
Communication-Electronics Research, Development and Engineering Center (CERDEC)	Joanne McBride	443-861-7654
JPEO-CBD	Larry Pollack	703-767-3307

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DoD requirements specified in the solicitation. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase I effort (up to **$100,000** with up to a six-month duration) AND an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

2. The proposal is limited to only **ONE** Army Solicitation topic.

3. The technical content of the proposal, including the Option, includes the items identified in Section 5.4 of the Solicitation.

4. SBIR Phase I Proposals have four (4) sections: Proposal Cover Sheet, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as THESE WILL COUNT AGAINST THE 20-PAGE LIMIT. ONLY the electronically generated Cover Sheet, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 5.4.e of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the “Company Commercialization Report” tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

5. The Cost Volume has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army prefers that small businesses complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

10. If applicable, Foreign Nationals are identified in the proposal. An employee must have an H-1B Visa to work on a DoD contract.

ARMY SBIR 15.3 Topic Index

ARMY SBIR 15.3 Topic Descriptions

A15-101 TITLE: Fast Charging Rate and High Energy Power Systems for High Shock Survivability

TECHNOLOGY AREA(S): Weapons

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: The objective of this topic is to develop fast charging rate and high energy power systems for gun-fired projectiles to survive high shock survivability of launch acceleration to 70,000 g's, to have a military shelf-life of 20 years, and survive flight vibrations to 10,000 cycles, and storage temperatures from -55 degrees C to 125 degrees C.

DESCRIPTION: This effort seeks proposals that apply multidisciplinary approaches including integration of innovative manufacturing methods, architectures and materials that demonstrates one or more Lithium-ion cells of size greater or equal to 0.5 Ah, scalable to support a 24 volt or larger applications, that is abuse tolerant to mechanical shock and vibration, operates in a wide range of thermal conditions with excellent cyclic performance, provides high rate performance compatibility, and low inherent materials and systems safety risks. Proposed power supply solutions for munition applications that require High Power and Long Duration performance. One example, at a voltage of 5 volts and a current of 0.13 amps, a power supply must last at least 10 hours in a cylindrical volume of 1.3 inch by 1.3 inch. A second application requires a power supply to provide current at a rate of 2 amps for 10 hours while maintaining a voltage of no less than 4 volts as a worst case, the physical size of the phase II prototype must be confined to the space occupied by 3 COTTS AA batteries.

In all application cases conformability of the power source is an added benefit to the applications, low cost and manufacturability are also of great importance. Meeting military shelf-life with minimum degradation as a function of the 20 year shelf-life is of great importance. Lithium ion batteries are known to supply high power and high energy capability and excellent storage capability on a weight to volume basis versus many available alternatives, offering promise for addressing power and energy shortfalls and requirements of US Army ARDEC. Nonetheless, criteria for ARDEC go beyond energy density where solutions are sought for not only for weight and volume reduction, but also extended operation time, high rate performance, and compatibility while operating in a wide range of ambient temperatures. Solutions also should be compatible with rugged operating environments, support criteria for low cost, high safety and reliability/maintainability, and provide other environmental compatibility. Moving lithium ion technology from the lab into the field has proven that such batteries may lack the extended cyclic performance, cycle life, and high rate compatibility when applied in demanding environments for armament and munitions systems. Additionally, Lithium-ion solutions may involve undesirable failure modes and risks that are not tolerant to military shock or operating conditions. Even in non-military environments, for example, there have been publicized risks of fires and explosions, recalling of laptop computers and issues for deployed aviation systems. ARDEC requirements for batteries can involve more demanding operating environments, need for greater cyclic performance, higher rate performance compatibility, and safety control in high mechanical shock environments including for dismounted and other munitions systems. ARDEC systems also must satisfy discharge and recharge in cold temperature environments and potentially high rate performance such as for rapid recharging or discharging beyond civilian requirements. No single solution has come forward to date for meeting these rigorous requirements, and it is anticipated that a combination of multi-disciplinary approaches including new materials, new architectures and new manufacturing methods would be needed are needed to fulfill military requirements.

PHASE I: Conduct a systematic study and subsequent design of a fast charging rate and high energy power system that meet the desired high shock survivability, military shelf life, and operational flight requirements and storage temperatures. A multi-disciplinary approach including novel design, engineering, materials selection and architecture qualification and the production of qualification data and test plans to support Phase II. These Phase I efforts will include all key required materials and design developments needed to produce one or more full Lithium-ion cells of size greater than 0.5 Ah in Phase II. Accordingly, Phase I will include a development/selection of anode, cathode, electrolyte and physical testing and qualification and selection for subsequent application in Phase II that will be compatible with future scaling to a 24 volt or larger application, capable of supporting a threshold of 5,000 cycles and objective of 10,000 cycles based upon subsequent accelerated time testing in Phase II, support and lead toward demonstration of discharge cycling in Phase II of no less than 80% of initial capacity after 500 cycles, and compatible with demonstration of high rate operation and recharging performance of at least 3C in Phase II.

Most portable batteries are rated at 1C, meaning that a 1,000mAh battery that is discharged at 1C rate should under ideal conditions provide a current of 1,000mA for one hour. The same battery discharging at 0.5C would provide 500mA for two hours, and at 2C, the 1,000mAh battery would deliver 2,000mA for 30 minutes. 1C is also known as a one-hour discharge; a 0.5C is a two-hour, and a 2C is a half-hour discharge.

The qualification, selection and design also should be compatible with enabling cold temperature cycling at -30F with favorable retention of capacity in Phase II. This Phase I effort also will address compatibility for abuse tolerance and deliver a final report that includes a test plan for use in Phase II including performance testing, high rate testing, and safety testing.

PHASE II: Will provide four milestone deliverables (1) The delivery of one or more full Li-ion cells of size greater than .5 Ah that are comprised of at least anode, cathode, electrolyte and physical design, materials and architecture selected in Phase I. (2) A concept design also will be provided to assess the scaling to a 24 volt or larger application and the elements of design for manufacturability. (3) A demonstration of high rate operation with a recharging rate of at least 3C, consistent with test plans developed in phase I. (4) The guidance and further documentation and test plan developed in Phase I to assist the Army in testing with a minimum of accelerated time testing that is indicative of supporting a threshold goal of 5,000 cycles and objective of 10,000 cycles. Initial qualification testing also may be undertaken to assess for retaining 80% of initial capacity after 500 cycles. A test framework also will be included for testing for cold temperature cycling at or approaching -30F with favorable retention of capacity. In addition, abuse tolerance testing may be undertaken for shock, nail testing and other methods to test for fire and explosion risks.

PHASE III: This technology would apply to weapon based platform applications. The commercial use could apply to the electric vehicle industry and also for energy recapture in industrial settings where renewable energy sources from machinery could provide huge cost savings.

REFERENCES:
1. Encyclopedia of Electrochemical Power Sources, C.K. Dyer et al, Elsevier Science (2010).

2. J. Dai, R. LaFollette, D. Reisner, “Thin film Cu5V2O10 Electrode for Thermal Batteries”, 218th Electrochemical Society Meeting, Las Vegas, NV, Oct.10-15, 2010, Meet. Abstr. - Electrochem. Soc. 1002 346 (2010)

3. R.M. LaFollette, J.Dai, D. Reisner, and D. Briscoe, “Thermal Battery with Thin film LiV3O8 Cathodes”, 218th Electrochemical Society Meeting, Las Vegas, NV, Oct.10-15, 2010, Meet. Abstr. - Electrochem. Soc. 1002 372 (2010)

4. J. Dai, D. Reisner, T. Kogut, and D. Briscoe, “High Voltage Cathode Material for Thermal Batteries”, 43rd Power Sources Conference, Philadelphia, PA, July 7-10, 2008, 10.2.

5. J. Dai, R. Laffellette, and D. Reisner, “High-Voltage Chemically Stable-Electrolyte for Thermal Batteries”, 44th Power Sources Conf., Las Vegas, NV, June 14-17, 2010, P35

6. J. Dai, D. Reisner, T. Kogut, and D. Briscoe, “Thin Film Oxide Cathode for Thermal Batteries”, 43rd Power Sources Conference, Philadelphia, PA, July 7-10, 2008, 10.3

7. R.A. Guidotti, F.W. Reinhardt, “Evaluation of the Li(Al)/MnO2 Couple in LiNO3-KNO3 Eutectic Electrolyte”, 41st Power Sources Conf., Philadelphia, PA, June 14-17, 2004, 9.3

8. N.V. Moss, D.H. Bhakta, “Gun Hardened Thermal Battery”, 40th Power Sources Conf., Cherry Hill, NJ, June 10-13, 2002, 21.4

9. "A comparison of the electrode/electrolyte reaction at elevated temperatures for various Li-ion battery cathodes," D.D. MacNeil, Z. Lu, Z. Chen, J.R. Dahn, J. Power Sources 108(2002) 8.

10. Linden, D. (Ed.), Handbook of Batteries 2nd Ed., McGraw-Hill Inc., New York (1995).

11. Bailey, J.C., “Comparison of Rechargeable Battery Technologies for Portable Devices,” Conference on Small Fuel Cells and the Latest Battery Technology, Bethesda, MD (1999).

12. R.A. Guidotti, F.W. Reinhardt, “A Miniature Shock-Activated Thermal Battery for Munitions Applications”, 38th Power Sources Conf., Cherry Hill, NJ, June 8-11, 1998, 10.5

13. J.D. Briscoe, “An Improved Thermal Battery for Millitary Applications, 38th Power Sources Conf., Cherry Hill, NJ, June 8-11, 1998, 10.7

14. F.C. Krieger, M.J. Shichtman, “Single-Pellet Thermal Batteries”, 39th Power Sources Conf., Cherry Hill, NJ, June 12-15, 200, 28.4

15. C.J. Crowley, N.A. Elkouh Creare, Inc., Hanover, “Plasma-Spraying Lithium Alloys for Thermal Batteries”, 39th Power Sources Conf., Cherry Hill, NJ, June 12-15, 200, 28.3

16. A.L. Golden, J. Dai, T. Danny Xiao Nad, D.E. Reisner, “Thermal Battery Using Plasma-Sprayed Thin-Film Cathodes”, 39th Power Sources Conf., Cherry Hill, NJ, June 12-15, 2000, 28.2

17. Handbook of Batteries, 3rd. Edition, by David Linden and Thomas B. Reddy.

KEYWORDS: multidisciplinary approaches, thermal conditions, high rate performance, low inherent materials, mechanical shock and vibration

TPOC-1: Carlos Pereira
Phone: 973-724-1542 x1542
Email: carlos.m.pereira1.civ@mail.mil

A15-102 TITLE: CFD Runtime Acceleration on New Chip Architecture

TECHNOLOGY AREA(S): Information Systems

OBJECTIVE: Develop a callable library of CFD numerical operations that exploit the performance of CFD solvers on new “many integrated core” processors such as the Intel® Xeon PhiTM.

DESCRIPTION: Computer chip makers like Intel have recently introduced the advanced Many-Integrated-Core (MIC) architecture [1] with the goal of enhancing performance for numerically intensive calculations like satellite imaging and computer gaming. These new processors offer an enormous increase in speed for these types of calculations over the more traditional chips that support standard PC applications. Recently, the DoD has began to upgrade their parallel High Performance Computer (HPC) systems to use these MIC processors because they greatly enhance the degree of parallelism available for numerical operations. Computational Fluid Dynaimic (CFD) codes used in Army rotorcraft analysis [2] could greatly benefit from these performance enhancements. Typical CFD runs today that require a week of compute time could be reduced to a day, making routine design iterations possible. Exploiting this enhanced degree of parallelism requires new programming strategies to exploit the vector processing units (VPUs) of the MIC architecture. Traditional MPI-based programming strategies used in the CFD codes today will not be effective [3]. CFD Codes are being developed in house and will be provided.

This proposal solicits a library of numerical operations performed by our CFD codes that achieve optimal performance on the MIC architectures. The Army's CFD codes are memory-bound, and the many-way parallelism offered by the MIC architecture will not increase the degree of memory available on today's processors. Hence, the proposed library should additionally include an analysis of the amount of memory used by the application. Specific requirements for the library include:

• Numerical operations that achieve optimal performance on MIC architectures
• Runtime memory analysis to determine when the problem size is too large
• Ability to be compiled with Army CFD codes under different compilers
• Cross platform compatibility (i.e. not specific to any particular operating system).

PHASE I: Demonstrate a callable library of a small subset of numerical operations in Army CFD codes that run on MIC processors.

PHASE II: Expand the library to include the wider set of numerical operations encompassing the entire CFD code. Demonstrate performance gains over traditional programming paradigms. Demonstrate memory reporting and clean shutdown when memory limits are exceeded. Demonstrate application of the library and performance gains for to real-world rotorcraft CFD calculations.

PHASE III DUAL USE APPLICATIONS: Operations in the library may be extended to include computational structural dynamics (CSD), comprehensive analysis, and other scientific computing applications of interest to the Army.

COMMERCIALIZATION: The proposed library can be readily used by commercial CFD codes developed outside the Army.

REFERENCES:
1. Chrysos, G.,"Intel® Xeon PhiTM Coprocessor – The Architecture," Intel Corporation, https://software.intel.com/en-us/articles/intel-xeon-phi-coprocessor-codename-knights-corner

2. Wissink, A.M., A.J. Katz, and J. Sitaraman, "Validation of 3D RANS-SA Calculations on Strand/Cartesian Meshes," Paper AIAA-2014-0416, 52nd AIAA Aerospace Sciences Meeting, Jan 13-17, 2014, National Harbor, MD.

3. S. Shende, A. Malony, A. Morris, and A. Wissink, "Simplifying Memory, I/O and Communication Performance Assessment using TAU," in Proc. DoD HPCMP UGC'10 Conference, IEEE Computer Society, 2010.

KEYWORDS: High Performance Computing, Intel MIC, parallel computing

TPOC-1: Andrew Wissink
Phone: 650-604-5385
Email: andrew.m.wissink@us.army.mil

A15-103 TITLE: Rotorcraft Elastic Fuselage Coupling with CFD

TECHNOLOGY AREA(S): Air Platform

OBJECTIVE: Develop coupling methodology for computational structural dynamics (CSD) and computational fluid dynamics (CFD) models of flexible rotorcraft fuselage and empennage structures to predict interactional buffet airloads, structural loads, and vibration.

DESCRIPTION: One of the most important, challenging, and chronic problems occurring during development of new or upgraded rotorcraft arises from the interactional aerodynamics of the complex, unsteady flowfield of the rotor, hub, and fuselage that generate significant adverse structural response of the flexible fuselage, horizontal and vertical tails, and the tail rotor of conventional helicopters. Similar problems arise for tilrotor and compound rotorcraft. Historically this problem has been nearly intractable with conventional aerodynamics and dynamics methodology, commonly leading to unexpected problems only revealed during prototype flight testing. As a consequence, expensive design changes, cut and try modifications, and program delays often occur. Current high-fidelity CFD/CSD rotorcraft modeling that aeroelastically couple rotor system CFD aerodynamics to flexible blade CSD structural models is presently limited to 1-D elastic beam rotor blade and rigid fuselage models. Furthermore, existing rotorcraft CSD/CFD coupling interfaces do not encompass distributed CFD airloads coupling with flexible fuselage and empennage surfaces or structural dynamics models of fuselage and empennage structures. Therefore, a new general approach for a CFD/CSD aeroelastic analysis to couple an elastic fuselage/empennage with current CFD aerodynamics and flowfields is needed to improve overall fuselage/empennage loads and vibration predictions. Coupling should be applicable to full FEM fuselage models as well as reduced-order modeling. In most cases CFD and CSD geometries and meshes are incompatible, and this must be considered. Needed approaches must provide solutions that satisfy the following requirements: 1) Must be rigorous, consistent and energy conserving, 2) General and easily applied for arbitrary rotorcraft configurations, 3) Message passing between CFD and CSD parallel processing programs (file based I/O may be used in Phase I), 4) Must be demonstrated on a practical real-world problem

PHASE I: Demonstrate the feasibility of the proposed fuselage CFD/CSD coupling approach by prototyping an elastic fuselage and developing initial coupling utilities. Prototype should demonstrate efficient and correct transfer of appropriate data between CFD and CSD programs.

PHASE II: Coupling utilities should be generalized for arbitrary fuselage configurations and user input should be automated to ensure ease of use. Interfaces will be developed for one or more CFD programs and the method shall be demonstrated on a real-world rotorcraft application.

PHASE III DUAL USE APPLICATIONS: Coupling utilities should be generalized for arbitrary fuselage configurations and user input should be automated to ensure ease of use. Interfaces will be developed for one or more CFD programs and the method shall be demonstrated on a real-world rotorcraft application.

REFERENCES:
1. Bhagwat, M., Dimanlig, A.C.B., Saberi, H.A., Meadowcroft, E.T., Panda, B., and Strawn, R.," CFD/CSD Coupled Trim Solution for the Dual-Rotor CH-47 Helicopter Including Fuselage Modeling, " American Helicopter Society Specialist's Conference on Aeromechanics, San Francisco, CA, January 23-25, 2008

2. Yeo, H., and Chopra, I., “Coupled Rotor/Fuselage Vibration Analysis Using Detailed 3-D Airframe Models,” Mathematical Modeling and Analysis of Rotary-Wing Systems, Vol. 33, Issues 10-11, May-June 2001.

3. Duque, E.P.N., and Meadowcroft, E.T., “Numerical Evaluation of Main Rotor Pylon Flowfields on the RAH-66 Comanche Helicopter,” American Helicopter Society 55th Annual Forum, Montreal, Canada, May 25-27, 1999.

4. Hassan, A.A., Thompson, T., Duque, E.P.N., and Melton, J., “Resolution of Tail Buffet Phenomena for AH-64DTM Longbow ApacheTM,” Journal of the American Helicopter Society, Vol. 44, No. 1, January 1999.

KEYWORDS: CFD, CSD, elastic fuselage, rotorcraft, coupling

TPOC-1: Hyeonsoo Yeo
Phone: 650-604-6168
Email: hyeonsoo.yeo.civ@mail.mil

TPOC-2: Mark Potsdam
Phone: 650-604-4455
Email: mark.a.potsdam.civ@mail.mil

A15-104 TITLE: Development of Additive Manufacturing for Aerospace Gear Applications

TECHNOLOGY AREA(S): Materials/Processes

OBJECTIVE: Develop and demonstrate an additive manufacturing process for advanced aerospace gears meeting or exceeding the mechanical properties of SAE AMS 6308.

DESCRIPTION: The lead time for manufacturing gears for testing in Science and Technology (S&T) prototype demonstrators can be several months and requires costly special tooling. Additive manufacturing is a manufacturing technique that can be used to reduce the lead time and cost for prototype hardware. Additive Manufacturing (AM) refers to a process by which digital 3D design data is used to build up a component in layers by depositing material.

The goal for this topic is to develop a new or improved AM process for aerospace quality gears in order for them to be used in prototype demonstrator applications. Potential AM processes that could be improved upon includes (but is not limited to) Laser Engineered Net Shaping (LENS) and Electron Beam Melting (EBM). The AM process must be developed to overcome existing challenges that limit the use of AM for gear manufacturing. Some of the common challenges/limitations are:

a. Residual stresses can be high in AM parts, which limit the loading of parts. Stress mitigation and optimization strategies must be developed as part of the effort.

b. Density of the material throughout AM parts can be inconsistent. Density can be influenced by un-melted entrapped powders. Overcoming this challenge needs to be addressed as part of the effort.

c. The rapid cooling rates associated with AM processes can affect the microstructure of the base material resulting in variations in desired strength, ductility, toughness, and modulus. The new AM processes must mitigate the effects to material properties.

Final components manufactured using the developed process must meet or exceed the mechanical properties of SAE AMS 6308 (Pyrowear 53). Pyrowear 53 may be considered as an Aerospace Grade 3 material, as defined in AGMA 926-C99. Any additional processing steps (such as hardening or surface finishing) must be defined, and should be minimized if possible. A method to vary the properties between the case and core regions of a gear must also be addressed. Specific metrics for the final manufactured gears are:

1) Minimum surface contact stress allowable = 250ksi
2) Minimum bending stress allowable = 40ksi
3) Minimum core hardness = 34 HRC
4) Minimum case hardness = 60 HRC
5) Minimum core yield strength = 140ksi
6) Minimum core ultimate tensile strength = 170ksi
7) Maximum surface finish = 16Ra

PHASE I: Demonstrate the feasibility of the new or improved AM process for use in additive manufacturing. Efforts should show that the formed parts can meet the properties equivalent to SAE AMS 6308 steel by utilizing simple geometric shape test specimens that have been produced using additive manufacturing

PHASE II: Contractors are encouraged to collaborate with an Army rotorcraft OEM during Phase II. The contractor shall further optimize the AM process based on the Phase I results. This optimization shall include developing methods to reduce additional gear manufacturing processes (such as carburization, peening, surface finishing) by altering the AM process. Coupon level testing shall be performed to demonstrate mechanical properties such as yield and ultimate tensile strength. Several sets of 4 inch diameter spur gears (representative of aerospace quality gears) shall be manufactured using the developed process. Testing and analysis of these final gears shall be performed to demonstrate that each of the topic metrics has been met. Additionally, the microstructure of the final gears shall be analyzed and compared to Pyrowear 53.

PHASE III DUAL USE APPLICATIONS: Transition the new process via aerospace Original Equipment Manufacturers (OEM) and/or qualified suppliers for Army rotorcraft. Demonstrate the AM process for actual aircraft components.

REFERENCES:
1. SAE International Aerospace Material Specification (AMS) 6308, available as Carpenter's Pyrowear 53 and Latrobe's Lesco 53

2. Additive Manufacturing - Definition is taken from the International Committee F42 for Additive Manufacturing Technologies (ASTM).

3. "Measurement Science Roadmap for Metal-Based Additive Manufacturing," NIST, May 2013

4. "Recommended Practices for Carburized Aerospace Gearing", from American Gear Manufacturers Association, Alexandria, VA, AGMA Information Sheet No. AGMA 926-C99, 1999.

5. "Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth", from ANSI/AGMA 2003-C10

6. "Metallic Material Properties Development and Standardization", MMPDS-08, April 2013

7. "Standard Test Methods and Definitions for Mechanical Testing of Steel Products", ASTM A 370-09, Jan 2009

8. "Standard Test Methods for Tension Testing of Metallic Materials", ASTM E8, May 2004

9. "Standard Test Method for Plane-Strain Fracture Toughness of Metallic Materials", ASTM E399, April 1991.

10. "Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials", ASTM E466, June 2002

11. "Standard Test Method for Measurement of Fatigue Crack Growth Rates", ASTM E647, April 2001

KEYWORDS: Gears, additive manufacturing, rotorcraft, drive system, transmission, Pyrowear

TPOC-1: Jason Fetty
Phone: 757-878-5741
Email: jason.r.fetty.civ@mail.mil

A15-105 TITLE: Innovative Matrix Systems for Carbon Fiber Reinforced Composite Tactical Rocket Motor Applications

TECHNOLOGY AREA(S): Materials/Processes

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop a general-purpose matrix approach using domestic, commercially available components, to provide matrix solutions for rocket motor structures fabricated using filament winding, resin infusion/transfer, and pultrusion-winding operations.

DESCRIPTION: Next-generation tactical propulsion systems require significantly more performance at the material level to support extended duration and multi-mission flexibility. In addition, the performance enhancements to current systems are accompanied by the need for lower cost material and processing technologies. Fiber reinforced polymer composites are extremely advantageous for many weight-critical structural applications, such as solid rocket motor cases and missile airframes, due to their high specific tensile strength and stiffness. In addition to weight savings over metals, composite rocket motor cases also offer higher operating pressures and improved Insensitive Munitions (IM) performance.

The many material-related benefits and advancements in composite fabrication technologies have facilitated the integration of composites into Army structures; however, many traditional matrix systems that are currently in use were originally derived for strategic and space-launch applications. These matrix systems, while well-suited for larger structures produced at lower volumes, have seen widespread use in the tactical propulsion community despite the fact that production quantities and rates are higher and operational and environmental requirements are more extreme. Furthermore, the focus on low-cost solutions for higher volume tactical propulsion applications has resulted in the move toward bonded end-fittings and other innovative joining techniques which impart interlaminar stresses within the composite. When confronted with multiple stressors and the increasingly severe demands of next-generation systems, traditional matrix systems have struggled to meet the challenge in a cost-effective manner.

Modern technology offers the opportunity to develop matrix formulations that achieve a better balance between processing, mechanical properties, and elevated temperature performance. Matrix solutions to mitigate stress-related delamination failure in tactical composite rocket motor cases and missile airframes are critical for the development of low-cost, high performance structures that meet the demands of next-generation systems.

Matrix solutions with glass transition temperatures above 400°F (and cure temperatures at or below 370°F) are desired. Due to cost constraints for tactical rocket motor case applications, solutions for this effort are limited to epoxy-based (single and multi-functionality) systems derived from domestic, commercially available components. Resin unit costs for the solution should not exceed that of commercially available 350°F glass transition temperature filament winding epoxy resin systems, and a cost analysis of a material and process developments should be included.

PHASE I: Offerors shall identify and investigate material and processing solutions that provide good processing, delivered fiber-direction tensile strength, and glass transition performance along with enhanced shear and flat-wise tensile laminate properties over state-of-the-art matrix systems. The material solution should also exhibit enhancements to Mode I and Mode II fracture toughness behavior. Material solutions should be processable using traditional wet filament winding processes at resin bath temperatures of <110°F. Material solutions should be capable of producing composite parts with fiber volume fractions of 60-65% and void contents less than 1.5%. Capability for high throughput in typical production environments must be considered (e.g., extended cure holds in excess of 6 hours should be eliminated). Offerors shall conduct formulation activities with strong consideration of potential material obsolescence issues. Resin rheological analysis and laminate mechanical property investigations shall be performed in order to substantiate the validity of the proposed formulations for the application. Offerors should develop methods to gain insight into fiber-matrix interaction with commercial high-strength, intermediate-modulus carbon fibers produced domestically within the United States. Offerors should include a cost analysis of the material and process development.

PHASE II: Offerors shall fabricate representative tactical rocket motorcase structures utilizing down-selected formulation(s) from Phase 1 and develop material allowables and supporting analysis for the intended application. Offerors shall explore tailoring of the proposed baseline matrix system for fabrication processes and applications and develop property-performance relationships. Modifiers/fillers to improve mechanical properties such as compressive strength, adhesion, modulus and glass transition will be investigated.

PHASE III DUAL USE APPLICATIONS: Demonstrate the matrix system's performance in a relevant environment. As this technology is pervasive, a Phase III application for integration into Army missile systems would include replacement of legacy matrix systems which are currently being used in composite missile structures across the Capability Areas. Programs that would benefit from this innovation are not limited to Army systems, but extend throughout the Department of Defense and to the National Aeronautics and Space Administration. In addition to composite missile structure applications, this technology could be utilized in commercial applications in the private sector of the aerospace industry.

REFERENCES:
1. "Composite Motor Cases for Tactical Missile Propulsion Systems," Michael Fisher and Thomas Moore, 41st AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, 10-13 July 2005, Tucson, AZ.

2. "High Temperature Matrices for Filament Wound Composites," Rock Rushing, 41st AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, 10-13 July 2005, Tucson, AZ.

3. "Solid Rocket Enabling Technologies and Milestones in the United States," Leonard H. Caveny, Robert L. Geisler, Russell A. Ellis, and Thomas L. Moore, Journal of Propulsion and Power 2003 19:6, 1038-1066.

4. "Structures Technology for Future Aerospace Systems," Ahmed K. Noor, Paul Zarchan, Progress in Astronautics and Aeronautics, Volume 188, Chapter 2: Affordable Composite Structures, pp. 27-91, October 2000.

5. Fisher, M.J., Moore, T.L., Hoffman, H.J., and Drewry, D.G., "Composite Rocket Motor Case Technology for Tactical Missiles," The Johns Hopkins University Chemical Propulsion Information Agency, CPTR 77, Columbia, MD, Aug. 2004.

6. Fisher, M., Moore, T., "Composite Motor Cases for Tactical Missile Propulsion Systems," 41st AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, 2005, 10.2514/6.2005-3611.

KEYWORDS: Fiber reinforced polymer composites, solid rocket motor cases, missile airframes, stress-related delamination failure, epoxy-based systems

TPOC-1: Amanda Napier
Phone: 256-876-1641
Email: amanda.b.napier.civ@mail.mil

A15-106 TITLE: Hybrid Thermoplastic Matrix Fabrication Methods for Missile Structures

TECHNOLOGY AREA(S): Materials/Processes

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop a methodology for producing low-cost, high-performance thermoplastic composite structures that contain highly detailed features for missile and aviation applications.

DESCRIPTION: Fiber reinforced thermoplastic matrix composites (TPMCs) provide improved damage tolerance, faster processing and assembly, reduced joint weight, virtually unlimited shelf life with minimal storage requirements, and recycling options which thermoset composites typically cannot offer. Through automated processing, TPMCs allows the potential for mass production of high stiffness/strength thermoplastic composites at lower costs. Despite the above advantages, the true benefits of TPMC missile structures have been limited by the constraints of available fabrication methods. For example, autoclave and compression molding techniques can process continuous fiber preforms that offer high strength and stiffness but are generally more suited to producing fairly simple geometric structures (e.g., plates, cones, box-structures). Injection molding methods, on the other hand, offer the ability to produce highly complex geometries, but even the most advanced molding compounds do not offer the structural performance of continuous preforms.

An ideal TPMC structure would combine compression molded and injection molded components into a single structure to retain cost and performance benefits. This ideal TPMC fabrication process should have a minimum cost reduction of 20% from traditional autoclave and compression molding manufacturing techniques. Joining techniques for TPMC components is an area of active research but this is a secondary process that decreases through-put and often requires access to the bond line for processing. For structures that could benefit from attaching multiple injection molded components to compression molded components, a direct method of attachment is desired.

PHASE I: Develop a design and fabrication strategy that combines multiple TPMC processing techniques for producing a low-cost, high performance TPMC structure. Structural properties should be a minimum of 50 Ksi tensile strength, 50 Ksi compression strength and 7 Msi tensile and compression modulus. The strategy should be able to accommodate producing structures as large as 1m x 1m, but contains detailed features, such as internal ribbing and other traditional stiffening elements. Demonstrate the feasibility at the coupon level to join TPMC components that have been produced by multiple fabrication methods.

PHASE II: Refine the design and fabrication strategy for producing more representative structures. Perform comprehensive studies and analyses of the structure to determine optimal fabrication method for the individual sub-components to balance cost and performance. Perform mechanical tests to demonstrate performance.

PHASE III DUAL USE APPLICATIONS: Upon successful completion of the research and development in Phase I and Phase II, produce prototype structures that can be demonstrated in field tests. Scale-up the design and fabrication strategy to be compatible for low rate and full production rate quantities. Demonstrate the TPMC structure can provide cost, weight, and performance benefits to applications outside the military.

REFERENCES:
1. Rudd, C.D.: "Feasibility of Low Cost Fabrication of Lightweight, Protective Structures using Thermoplastic Matrix Composites", US Naval Tech Report # N68171-L, 2001

2. Mallick, P.K.: "Thermoplastics and thermoplastic-matrix composites for lightweight automotive structures", University of Michigan-Dearborn, 2010

3. Harper, Robert C. "Thermoforming of Thermoplastic Matrix Composites. I." SAMPE Journal 28 (1992): 9-17.

4. Amancio-Filho, S., and J. F. dos Santos "Joining of Polymers and Polymer-Metal Hybrid Structures: Recent Developments and Trends." Polymer Engineering and Science 49.8 (2009): 1461-76.

5. Nguyen, Ba Nghiep et al. "Validation of New Process Models for Large Injection-Molded Long-Fiber Thermoplastic Composite Structures." Richland, WA: U.S. Department of Energy Pacific Northwest National

Laboratory, 2011. PNNL-21165.

KEYWORDS: thermoplastic matrix composites, thermoplastic matrix composites missile structures, injection molding, back molding, joining technique of thermoplastic, cost effective fiber reinforced thermoplastic matrix composites

TPOC-1: Daniel Carter
Phone: 256-842-0815
Email: daniel.w.carter1@us.army.mil

A15-107 TITLE: Novel Materials for Kinetic Energy Penetrators

TECHNOLOGY AREA(S): Weapons

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Identify and produce a low-cost material that matches or exceeds the performance of depleted uranium (DU) in kinetic energy (KE) penetrator applications.

DESCRIPTION: Beginning in the 1970s, depleted uranium was selected as a replacement for tungsten alloys used in a variety of armor-piercing projectiles. DU matches the density of tungsten with the added benefit of “self-sharpening” through adiabatic shear banding. DU penetrators also exhibit pyrophoric effects as they impact a target and partially aerosolize, enhancing lethality and improving anti-materiel efficacy.

In addition to enhanced performance, the manufacturability, low material cost, and abundant supply of DU have made it a practical choice for KE penetrators.

Limited opposition to the use of DU exists in some circles based on the idea that, as a heavy metal, depleted uranium deposited on the battlefield might represent a serious persistent health or environmental hazard. Because of this opposition, the Army has been exploring alternative materials for KE penetrator applications.

This SBIR topic requests a fully dense KE penetrator material that matches or exceeds the ballistic performance of depleted uranium.

The cost of the proposed material should not exceed 200 percent of the cost of military grade tungsten heavy alloy purchased in production quantities. The Army may consider materials and processes that exceed this cost ceiling if they provide exceptional KE penetrator performance or if they offset the material cost through reductions in other life-cycle costs.

The material proposed should be less toxic than conventional tungsten nickel cobalt heavy alloys.

PHASE I: The offeror should use a multiscale materials modeling approach, such as Integrated Computational Materials Engineering (ICME), to develop material options to replace depleted uranium in the kinetic energy penetrator application.

The materials developed shall meet or exceed the terminal ballistic performance of current depleted uranium alloys. The result of the modeling effort shall be the complete description of the materials, including, but not limited to, composition, crystal structure, phase identification, preferred microstructural features, and expected mechanical and physical properties.

The offeror shall demonstrate the synthesis and fabrication of the most promising candidate material composition. The offeror will deliver 12 identical samples of the material in kinetic energy penetrator form (5.6 mm diameter and 16.7 mm in length).

Create a scale-up strategy for material production, and perform a cost analysis describing the anticipated cost of full-scale production.

PHASE II: The offeror shall build on the insight provided by the Phase I materials modeling effort and the results of the Phase I ballistic characterization to optimize the candidate composition. The offeror shall scale up the synthesis and processing of the down-selected material sufficiently to produce a single batch of material to fabricate 25 identical penetrator rods (65g mass, 15:1 length to diameter ratio, right circular cylinder, dimensional tolerances shall be provided).

The offeror shall perform ballistic characterization with these penetrators against standard 3" rolled homogenous armor (RHA) at zero degrees obliquity or similar tests, comparing these results against conventional tungsten penetrators.

The offeror shall also fabricate from a single batch of material an additional 25 identical copies of these penetrators for delivery to the Army for independent characterization. Tests should be structured to enable comparison with past DU test data.

Further optimize the composition and material properties based on Phase II ballistic test results to meet launch survivability and terminal ballistics requirements.

Deliver 25 prototypes (half-inch diameter, eight-inch length) to the Army for testing.

PHASE III DUAL USE APPLICATIONS: Scale up material for tests in 120mm tank rounds.

Private sector applications include the use of projectiles to replace high explosive charges for cutting hard surfaces in mining, drilling, excavation, demolitions, and salvage operations.

REFERENCES:

1. "Front Matter", Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security. Washington, DC: The National Academies Press, 2008. http://www.nap.edu/openbook.php?record_id=12199&page=R1. (Accessed August 19, 2014).

2. Ryan T. Ott et al., Synthesis of high-strength W-Ta ultrarine-grain composites, J. Mater. Res., 23 (2008) 133-139.

3. Min Ha Lee and Daniel J. Sordelet, Shear localization of nanoscale W in metallic glass composites, J. Mater. Res, 21 (2006), 492-499.

4. X.F.Xue, et al., Strength-improved Zr-based metallic glass/porous tungsten phase composite by hydrostatic extrusion, Appl. Phys. Let, 90 (2007)

5. Tapan K. Chatterjee, K T. Ramesh and John B. Posthill, "Electron Microscopy of Tungsten Heavy Alloys After High Strain Rate Tests" Microscopy Society of America, August 1-5, 1994, New Orleans.

6. Ames Laboratory, "Nanostructured Material Offers Environmentally Safe Armor-piercing Capability, May Replace Depleted Uranium." ScienceDaily. www.sciencedaily.com/releases/2007/01/070131103534.htm (accessed August 19, 2014).

7. Lee S. Magness. "High Strain Rate Deformation Behaviors of Kinetic Energy Penetrator Materials during Ballistic Impact." Mechanics of Materials: 147-54.

8. Michael J. Keele, Edward J. Rapacki Jr., and William J. Bruchey Jr., "High Velocity Performance of a Uranium Alloy Long Rod Penetrator," Technical Report BRL-TR-3236, Ballistic Research Laboratory, http://www.dtic.mil/dtic/tr/fulltext/u2/a236191.pdf (Accessed June 17, 2015).

KEYWORDS: Amorphous metals, Kinetic Energy Penetrators, depleted uranium, nanostructured materials, alloy nanopowders, advanced materials, tungsten.

TPOC-1: Tapen Chatterjee
Phone: 973-724-9457
Email: tapan.k.chatterjee@us.army.mil

A15-108 TITLE: Innovative Technologies for Detection and Discrimination of Surface and Buried Explosive Hazards

TECHNOLOGY AREA(S): Electronics, Sensors

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Design and develop novel and innovative sensor technologies for stand-off detection and discrimination of surface and buried explosive hazards.

DESCRIPTION: Sensor investments in counter explosive threat technologies during Operation Enduring Freedom and Operation Iraqi Freedom have resulted in the solution of many niche problems but provided few long-term solutions for sustaining operational tempo, assured mobility and survivability. In order to address emerging and evolving threats, novel and innovative technologies are required. Capabilities from these technologies could lead to improved buried in-road and surface side attack threat clearance as well as standoff threat identification. This SBIR will seek development of novel and innovative sensor technologies to detect and discriminate surface and/or buried explosive hazard targets. A successful proposal will explain the phenomenology the sensor seeks to exploit and how that phenomenology relates to either buried or surface explosive hazard targets, such as discrimination between natural and man-made objects. Proposals that provide sensor solutions relevant to either buried or surface targets will be accepted, but sensors that are applicable to both problem sets are preferred. Technology solutions, other than ground penetrating radar, are preferred. The proposed development activity only needs to focus on a single phenomenology to be exploited, however technologies that can show applicability to multiple Army problem sets or multiple phenomenologies are preferred, such as disturbed earth, threat and common clutter detection.

PHASE I: The Phase I goal is to demonstrate the proposed sensor technology, the phenomenology being exploited and the utility of that phenomenology in detecting and discriminating the targets of interest. The Phase I work can be accomplished using modeling and simulation, but a data-driven experiment using actual hardware (bench-top or early prototype) is preferred. A Phase I report is required.

PHASE II: The Phase II goal is to develop a prototype demonstration sensor. The prototype sensor should be capable of collecting data in a controlled setting. During Phase II, the prototype sensor will be used to demonstrate the utility of the sensor and phenomenology being exploited. The Phase II final report must include a description of the developed sensor, a study validating the sensor and the phenomenology being exploited, problems discovered with the sensor/phenomenology, and recommendations for future sensor improvements.

PHASE III DUAL USE APPLICATIONS: Mature the sensor such that it can be fielded by the military or sold commercially for homeland security applications. This includes improvements described in the Phase II report. Develop Aided Target Recognition (AiTR) algorithms to detect and discriminate targets of interest. The resulting sensor could then be fielded for use in detecting buried or roadside hazards during military operations or for detecting buried or roadside hazards or other concealed structures of interest by city planners and utility/highway inspectors.

REFERENCES:
1. Proceedings of SPIE -- Volume 5415, Detection and Remediation Technologies for Mines and Minelike Targets IX, Russell S. Harmon, J. Thomas Broach, John H. Holloway, Jr., Editors, September 2004, pp. 1035-1041

2. Detection Algorithms for Hyperspectral Imaging Applications, Manolakis & Shaw, IEEE Signal Processing Magazine (1053-5888/02) January 2002, pp. 29-43.

3. Faceted grating prism for a computed tomographic imaging spectrometer, Kudenov et. al., Optical Engineering 51(4), 044002 (April 2012)

4. Standoff Raman Hyperspectral Imaging Detection of Explosives, Wentworth, R. M., Neiss, J. H., Nelson, M. P., Treado, P. J. (2007), Proc. IEEE. Antennas and Propagation International Symposium. pg. 4925-4928

5. Development and Initial Results of the LACHI Compact LWIR Hyperspectral Sensor at US Army RDECOM CERDEC NVESD, Zeibel et. al., Military Sensing Symposium on Passive Sensors. (March 2011).

6. Recent Advances in Mobile Ground-Based Hyperspectral Detection of IEDs, Home Made Explosives, and Energetics-Related Materials., Yasuda et. al., Military Sensing Symposium on Battlefield Survivability and Deception. (March 2012).

7. Compressive Sensing, Richard Baraniuk, IEEE Signal Processing Magazine, 24(4), pp 118-121, July 2007.

8. Compressed sensing for practical optical imaging systems: a tutorial, Rebecca Willett, Roummel Marcia, and Jonathan Nichols, Optical Engineering, vol. 50, no. 7, pp. 1-13, 2011.

9. Optical Image Processing using Light Modulation Displays, Gordon Wetzstein, Wolfgang Heidrich and David Luebke, Computer Graphics Forum, Vol 29, Issue 6, pp. 1934-1944, Sept 2010

10. Detection of disturbed earth using passive LWIR polarimetric imaging, Gurton, K. Felton, M., Proc. SPIE 7461, Polarization Science and Remote Sensing IV, 746115 (August 11, 2009); doi:10.1117/12.837779

KEYWORDS: counter explosive hazards, buried target detection, roadside target detection, sensor development

TPOC-1: Christopher Marshall
Phone: 703-704-1050
Email: christopher.h.marshall@us.army.mil

A15-109 TITLE: Multi-static Ground Penetrating Radar for Buried Explosive Hazard Detection

TECHNOLOGY AREA(S): Electronics, Sensors

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Design and develop a multi-static Ground Penetrating Radar (GPR) system that is capable of detecting buried explosive hazards from a standoff distance.

DESCRIPTION: Current standoff GPR systems operate in a mode that is essentially equivalent to monostatic. The transmit and receive antennas are located close to each other so the phenomenology of target and clutter responses are as if the same antenna was used for transmit and receive. This modality has shown to have some capability to detect buried explosive hazards at standoff, but the detection performance has not reached that of close-in systems. There is a desire to detect targets from a distance, and investigations are underway using additional modalities to improve performance. One possible way to do this is to try and increase the signal level received from targets. In most standoff GPR systems, the antennas are positioned with a relatively low grazing angle relative to the target, limiting the energy that can penetrate into the ground. Having antennas at different positions and/or orientations may help improve the signal level received from the target versus what is received from clutter. Another advantage that close-in, downward looking GPR systems have relative to standoff systems is that they have good 3-Dimensional resolution that allows them to separate the response from the surface from objects buried beneath it. Standoff systems typically only have resolution in 2 dimensions which causes the responses of targets and the ground to be combined. Novel multi-static orientations may allow for better resolution in 3 dimensions. The objective of this effort is to investigate and design a fully bi-static or multi-static GPR system to better learn about the phenomenology of the responses from targets and clutter and to find ways to better discriminate between the two. The desired system could consist of a ground vehicle, Unmanned Aerial Vehicle (UAV), or a combination of the two. A ground vehicle would need to operate at ranges of at least 15 meters from targets. Ground penetration of at least 15 cm and sufficient resolution are required. The system should be capable of detecting 80% of buried targets with a False Alarm Rate of 10 per linear km of road. The system may utilize any active transmitters inherent to itself, transmitters present in the ambient environment, or some combination of the two. Other sensing modalities could be used to extract higher resolution range information to enhance further processing

PHASE I: The goal of Phase I is to create multi-static radar design and supporting quantitative analysis with the objective of detecting buried explosive threats in cluttered environments. The offeror should model spatial antenna configurations for optimized signal to clutter performance. Simple lab experiments may be used to support the model as related to electromagnetic response strength of targets, soil, and clutter. The deliverable of Phase I will be a report that includes the results of the phenomenology study and a preliminary-design for proof-of-concept equipment.

PHASE II: The design created in Phase I will be expanded and used to produce a field setup (TRL 5). The equipment will be used to verify parameters of the model that affect detection performance. The phenomenology of the targets and clutter will be validated to support the proposed detection configuration. The deliverable will include an expanded model comparing detection performance for multiple configurations. Also deliverable are field equipment, data, and data analysis supporting the principle assumptions of the model and illustrating detection improvements over monostatic configurations.

PHASE III DUAL USE APPLICATIONS: The hardware design will be further refined and a technology demonstrator will be constructed for field use. The system developed under this effort will have high potential for other commercial applications for underground surveying and humanitarian demining, and other homeland security agencies.

REFERENCES:
1. Yukinori Fuse; A novel forward and backward scattering wave measurement system for optimizing GPR standoff mine/IED detector. Proc. SPIE 8357, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XVII, 835714 (May 10, 2012); doi:10.1117/12.922865.

2. William W. Clark; Brian Burns; Gary Dorff; Brian Plasky; George Moussally; Mehrdad Soumekh; Wideband radar for airborne minefield detection. Proc. SPIE 6217, Detection and Remediation Technologies for Mines and Minelike Targets XI, 621721 (May 18, 2006); doi:10.1117/12.673479.

3. Brian R. Phelan; Kelly D. Sherbondy; Kenneth I. Ranney; Ram M. Narayanan;
Design and performance of an ultra-wideband stepped-frequency radar with precise frequency control for landmine and IED detection. Proc. SPIE 9077, Radar Sensor Technology XVIII, 907708 (May 29, 2014); doi:10.1117/12.2050928.

4. Timothy C. Havens; John Becker; Anthony Pinar; Timothy J. Schulz;
Multi-band sensor-fused explosive hazards detection in forward-looking ground penetrating radar. Proc. SPIE 9072, Detection and Sensing of Mines, Explosive Objects, and Obscured Targets XIX, 90720T (May 29, 2014); doi:10.1117/12.2051034.

KEYWORDS: Ground Penetrating Radar, Unmanned Aerial Vehicle, Synthetic Aperture Radar, Compressed Sensing, Multi-static Radar, Bi-static Radar, Buried Explosive Hazard Detection

TPOC-1: Brian Burns
Phone: 703-704-0052
Email: brian.burns6@us.army.mil

A15-110 TITLE: Continuous IAVA Mitigation & Remote Client Support for Tactical Systems

TECHNOLOGY AREA(S): Information Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 5.4.c.(8) of the solicitation.

OBJECTIVE: Develop a patch management system capable of providing automated and continuous Information Assurance (IA) patches for fielded, tactical systems, while providing a remote capability for auditing and assessing system vulnerability.

DESCRIPTION: In accordance with the Army Cyber Command Operations Order (OPORD) 2011-051, vulnerabilities are exploitable weakness in software that provide an adversary with an opportunity to compromise the confidentiality, integrity, and/or availability of an Information System (IS). These vulnerabilities are being actively exploited in DoD networks and pose a high risk to Army IS. Consequently, units are being required to expedite efforts to mitigate risks posed by vulnerabilities.

The current operational tempo is such that, IAVAs are network accessible via AKO, on a monthly basis for connected systems. IAVAs are replicated and distributed via CD/DVD on a quarterly basis for systems without network connectivity. In an effort to meet army demands for increased timeliness of IAVA releases, the Army will be required to release IAVAs at an accelerated rate for each system's state of connectivity.

Historically frequent updates typically require additional resources in terms of engineering (test-fix-test) cycle. This would also effectively increase utilization of additional resources such as replication, installation and distribution services and therefore lifecycle cost. Continuous updates will also increase impacted Field Support Engineers (FSEs), requiring them to install software on a frequent basis for the units in the field.

Current sustainment efforts include an initial scan of the system for identification of IA vulnerabilities. These vulnerabilities are collected over a period of time, mitigated and finally tested. If items do not successfully pass, they must be documented in the Plan of Action & Milestones (POA&M) and mitigated at a later date. Once the system has successfully passed all testing (or POA&M is updated accordingly) all IAVA fixes are packaged into a software release and fielded. While the system is in the field, there is potential that new threats will be identified that leave the system in a vulnerable state. As a result, a patch must again be applied, tested and delivered, no later than 72 hours after notification.

When a physical release of IAVA updates occur, especially on a monthly basis for instance, software sustainment costs increase drastically. Systems must be validated and verified; POAM are required to be updated; test reports must be prepared, software must be shipped more frequently and Field Service Engineering support increases. When occurring at an accelerated rate and deviating from the standard quarterly IAVA release, the demand on available resources also increases.

The below are metrics which estimates cost of monthly IAVMs for a single baseline over a 12 month period:

Gather IA threats and collect at least monthly; scan, mitigate, test, and deliver an IAVM update monthly; update POAM monthly: $600K

Develop, test and deliver an emergency IAVM update as required with delivery no longer than 72 hours after notification (two per month): $750K

Conduct validation and verification scans of the monthly update; prepare and deliver “Results” report: $300K

Vendor CM, QA, delivery, printing, material, shipping $300K

SEC CM and Release: $30K

RDIT distribution of Monthly Releases to FSRs; electronic distribution of Emergency Releases to units: $30K

Field Service Engineer install and validate installation $3500K

Total Cost: $5510K

Development of a technical solution which ensures that IAVAs are released on a continuous basis is required, with the capability to identify potential threats and conduct vulnerability assessments in near real-time. The solution should also be capable of providing a complete view of vulnerability and exploit risks, based on threat insights. Frequent IAVA updates to software will be required to mitigate issues and protect Army tactical systems while reducing software sustainment cost.

Supported software resides on multiple domains ranging from unclassified through TS/SCI. There is a need to keep IAVA mitigation at the lowest classification possible to allow for ease of access by system administrators (FSEs & 35Ts) and replication if required. Currently monthly IAVAs are posted to AKO-S, which presents a challenge for disconnected systems which reside on other domains or systems on closed networks that need the updates prior to the distribution on CD/DVD.

A network-only solution will require an instantiation on every possible domain and there will still be a need to remediate systems that require reloading or have been disconnected from a network for a period of time. The connection must create secure electronic software distribution for issue mitigation. The network solution will also be required to possess a secure software tool which allows for remote access across each domain. The intent of the tool is to assist units with quickly resolving technical issues which may arise while updating software. This will assist with reducing FSE manpower while enhancing the user experience for the Warfighter.

PHASE I: Develop a concept which documents a process for developing a patch management system capable of providing automated and continuous Information Assurance (IA) patches for fielded, tactical systems, while providing a remote capability for auditing and assessing system vulnerability.

Provide a detailed design of a solution that provide the capability to identify potential threats and conduct vulnerability assessments in near real-time and mitigate IAVA issues. The solution also shall provide remote IAVA updates to software to Army tactical systems while reducing software sustainment cost. Complete a system design concept and demonstrate through modeling, analysis, or prototype that it meets the requirements. A requirements analysis report and a design study document shall be part of the final report. The final report shall also include estimated cost for development of the capability.

PHASE II: Develop a working prototype augmented reality capability of IAVA Management system for use with Tactical System that is based on the selected Phase I design.

Interface the capability to the Army's network through the use of a tactical system. Perform evaluation tests of the capability using simulated mission scenarios and validates that the approach identify, mitigate issues and remotely update IAVA patches to Tactical Systems. In addition to delivering the prototype augmented reality capability, a report shall be submitted detailing testing and demonstration results. This report shall identify key performance parameters related to how the augmented reality to mitigate issues and protect Army tactical systems while reducing software sustainment cost.

PHASE III DUAL USE APPLICATIONS: Implement solution as part of a tactical system and deploy the system for test and evaluation using commercially available technologies. The implementation should ensure that the system is interoperable with existing system of systems. Perform steps required to commercialize the system. In conjunction with Army, optimize the prototype created in Phase II. The technology developed should result in a capability that can be used by the Warfighter.

REFERENCES:
1. http://www.prim.osd.mil/cap/iavm_req.html?p=1.1.1.1.3

2. https://atechnologyjobisnoexcuse.com/2012/01/disa-releases-iava-to-cve-mapping/

3. https://en.wikipedia.org/wiki/Information_assurance_vulnerability_alert

4. http://www.dtic.mil/dtic/tr/fulltext/u2/a390651.pdf

KEYWORDS: IAVA, Cyber Security, Remote Install, FSE, Tactical

TPOC-1: Huy Pham
Phone: 443-861-3768
Email: huy.pham@us.army.mil

A15-111 TITLE: Real-time Measurement of Dose from Prompt Gamma and Neutron from Nuclear Blast

TECHNOLOGY AREA(S): Nuclear Technology

OBJECTIVE: Develop a real-time detector capable of accurately measuring the dose from prompt gamma and prompt neutron from a nuclear blast.

DESCRIPTION: The Defense community has a need for detecting and measuring the prompt gamma and prompt neutron from a nuclear blast. When a nuclear weapon detonates, it creates both prompt (also called initial) and residual radiation. Prompt neutrons result almost exclusively from the energy producing fission and fusion reactions, while prompt gamma radiation includes that arising from these reactions as well as that resulting from the decay of short-lived fission products (Ref. 1, FM 8-9). For small tactical nuclear weapons (under 50 kT), the prompt radiation is one the most predominate causes of casualties, more than the blast wave and thermal (Ref. 1, FM 8-9 table 3-I).

The prompt radiation occurs in a very short pulse, lasting only a few microseconds. Thus it is exceedingly hard to accurately measure real-time. Currently, the warfighters have both passive dosimeters and real-time dosimeters. Passive dosimeters such as as film badges, Thermo luminescent Dosimeters (TLDs), or Optically Stimulated Luminescence (OSL) detectors accurately measure the prompt radiation. The Army's PDR-75A uses OSL technology and can accurately measure the prompt radiation. However, it is not a real-time system. The warfighter must stop what they are doing and read the dosimeter in a reader to determine their dose. The current real-time dosimeters such as the UDR-13 can provide real-time measurements, but are extremely inaccurate (sensitivity around 30 cGy). The warfighters currently do not have capability to accurately measure prompt radiation accurately in real-time.

There are several technologies that have been developed or advanced in the last few years that make real-time measurement of prompt doses possible, feasible, and affordable. Recent advances in OSL devices along with advances in optic sources and measurement devices may allow the development of a device that can accurately measure prompt gamma and neutron in real-time or near real-time. There have also been advances in MOSFET and Pin-diodes that may allow the use of those technologies for the needed measurements. The goal of this research would be the development of such an innovative detector for eventual use on radiation detectors for vehicles and personal.

PHASE I: Demonstrate the proposed technology can accurately measure the prompt gamma and prompt neutron doses in real-time (or near real-time) via breadboard validation in laboratory environment (TRL 4). The initial step is to design and fabricate a breadboard prototype using the proposed technology. The next step is to test the breadboard prototype against prompt gamma and prompt neutron environment (i.e. the pulse reactor at White Sands Missile Range (WSMR)) to assess the capability of proposed technologies to meet the need. The final step is to review and analyze the data to determine the feasibility of the proposed technology to fulfill the Army's need to accurately measure the prompt gamma and prompt neutron doses in real-time.

PHASE II: In Phase II, demonstrate the proposed technology can accurately measure the prompt gamma and prompt neutron doses in real-time (or near real-time) through high-fidelity breadboard validation in a relevant environment (TRL 5 or greater). Design and fabricate a high-fidelity breadboard prototype apparatus with the proposed technology integrated with reasonably realistic supporting elements. Test the breadboard prototype apparatus in a relevant environment to include prompt gamma and prompt neutron as well as other relevant challenges such as temperature, EMP, and vibration. The purpose of testing is to ensure the ability of the technology demonstrates the needed capability to accurately measure the dose from prompt gamma and prompt neutron in real-time, but also to determine if any potential limitations of the technology prevent the eventual fielding of the technology. The final step is to review and analyze the data to determine if the technology will fulfill the Army's need to accurately measure prompt gamma and prompt neutron doses in real-time in a relevant environment.

PHASE III DUAL USE APPLICATIONS: If Phase II is successful, Phase III will further refine a final deployable design, incorporating design modifications based on results from tests conducted during Phase II, and improving engineering/form-factors, equipment hardening, and manufacturability designs to meet U.S. Army CONOPS and end-user requirements.

REFERENCES:
1. FM 8-9, NATO Handbook on the Medical Aspects of NBC Defensive Operations, 1996.

2. Reuven Chen and Vasilis Pagonis, "Optically Stimulated Luminescence (OSL), in Thermally and Optically Stimulated Luminescence: A Simulation Approach", John Wiley & Sons, Ltd, Chichester, UK. doi: 10.1002/9781119993766.ch7 (2011).

3. Benoit, D.; Garcia, P.; Matias-Vaille, S.; Ravotti, F.; Vaille, J.R.; Glaser, M.; Brichard, B.; Fernandez, A.F.; Chatry, C.; Dusseau, L., "Real-Time Fibered Optically Stimulated Luminescence Dosimeter Based on SrS:Ce,Sm Phosphor," Nuclear Science, IEEE Transactions on, vol.55, no.4, pp.2154,2160, A

4. Benoit, D.; Garcia, P.; Matias-Vaille, S.; Ravotti, F.; Vaille, J.R.; Glaser, M.; Brichard, B.; Fernandez, A.F.; Chatry, C.; Dusseau, L., "Real-time fibered optically stimulated luminescence dosimeter based on SrS:Ce,Sm phosphor," Radiation and Its Effects on Components and Systems, 2007. RADECS 200

5. Rosenfeld, A.B.; Carolan, M.G.; Kaplan, G.I.; Allen, B.J.; Khivrich, V.I., "MOSFET dosimeters: the role of encapsulation on dosimetric characteristics in mixed gamma-neutron and megavoltage X-ray fields," Nuclear Science, IEEE Transactions on, vol.42, no.6, pp.1870,1877, Dec 1995.

6. Hu, A.Q.; Yu, M.; Zhou, C.Z.; Fan, C.; Liu, C.C.; Wang, S.N.; Shi, B.H.; Qi, L.; Wang, J.Y.; Jin, Y.F., "Bilateral PIN Diode for Fast Neutron Dose Measurement," Nuclear Science, IEEE Transactions on, vol.61, no.3, pp.1311,1315, June 2014.

KEYWORDS: nuclear radiation detection, prompt gamma, prompt neutron, real-time detection

TPOC-1: Chad McKee
Phone: 410-436-1092
Email: chad.b.mckee@us.army.mil

A15-112 TITLE: Stabilization of Phage for Far-forward Fieldable Applications

TECHNOLOGY AREA(S): Chemical/Biological Defense

OBJECTIVE: Leverage phage-based technologies to develop fieldable assays and demonstrate the long-term stability of these assays.

DESCRIPTION: Technologies that enable biological detection and presumptive identification with low operational burden are needed as future Warfighter capabilities. Lateral flow immunoassays (LFIs) have remained the go-to technology for approximately 20 years despite a plethora of lab-based techniques that vastly outstrip LFIs in critical qualities such as sensitivity and specificity. This persistence of LFIs demonstrates the overwhelming importance of ease of use and low operational burden to technology adoption. While huge investments in pushing lab-based techniques towards ruggedization and simple operation are resulting in advances, platform technologies that start from a position of low operational burden and expand capabilities beyond LFIs are attractive. Meanwhile, interest in phage for a range of applications has significantly increased in recent years. Department of Defense (DoD)-relevant applications include bacterial detection, identification, decontamination, and treatment, especially of antimicrobial resistant strains. Phage offers high host specificity, built-in replication, abundance in nature, and ease of production, amongst other properties. Indeed, modified phages have been demonstrated in the lab as a highly sensitive and specific method to detect biological warfare agents such as Bacillus anthracis and Yersinia pestis. Research into the stability of phage after lyophilization spanning several decades has shown mixed results for different phage and for different preparation methods; yet, significant success suggests that phage could present an excellent approach to fielded biological detection. This topic seeks innovative development of phage-based detection and identification technologies that are highly fieldable. More specifically, ideal assays would be simple to operate, inexpensive, disposable, and require little or no equipment to analyze results; however, they must also continue to enhance the sensitivity and specificity of the assay. Determining the technical merit of using phage as the main component of fieldable assays, by determining a method for stabilization, would help drive forward the current metrics for detection and identification. While an LFI format is not specifically requested, proposed approaches should use the success of this format as a template; especially the ability to demonstrate operability in austere environments is highly encouraged.

PHASE I: Proof-of-concept will require the production of at least one specific assay that incorporates the use of a stable phage as a main component of the final design. This assay should address the ability to operate in austere environments, while continuing to be simple to operate, inexpensive (ie. less than $100/test, with a clear path towards cost reduction), disposable, and require little or no equipment to analyze results. For demonstration purposes in Phase I, detection limits are not as essential as stability of the assay components.

PHASE II: The offeror will develop functioning assays with improved limits of detection for more than one target of specific interest to the DoD. Detection of actual threat agents is encouraged but not necessarily required. However, demonstration of enhanced stability capabilities above what was demonstrated in Phase I, such as resistance to environmental fluctuations (ie. storage temperatures up to 30ºC, with up to 50ºC being optimal, and operational temperatures robust up to a 5ºC variation from ideal conditions set by the offeror) regardless of the target is also expected. At the conclusion of Phase II, the assays developed should be able to be tested for both reproducibility and accuracy of results at several storage and operational temperatures. Furthermore, suitable testing partners should be identified for threat agent testing, as work with many specific agents is highly restricted.

PHASE III DUAL USE APPLICATIONS: Efforts in both Phase II and Phase III should be clearly directed towards transition to field use. Potential limitations in sample preparation requirements, sensitivity, robustness, etc. should be clearly indicated. Avenues to overcome these limitations in potential Phase III work should be outlined. Potential products using the same technology that are not specific to DoD needs may involve different limitations (e.g. robustness to austere operations), and these separate limitations should also be outlined.

Inexpensive, disposable, ruggedized detection of biological threat materials or other targets have several uses outside the DoD. Most obviously, detection of a much wider range of threats would useful in hospital or remote clinic settings. Other applications include detection of biological targets for industrial or personal use (e.g., food safety, pathogen detection, etc.)

REFERENCES:
1. E. Celik, A.A. Ollis, Y. Lasanajak, A.C. Fisher, G. Gur, D.F. Smith, and M.P. DeLisa. “Glycoarrays with engineered phages displaying structurally diverse oligosaccharides enable high-throughput detection of glycan-protein interactions. Biotechnol J, published online: DOI 10.1002/biot.201400354. (201

2. J. Kulpakko, K. Kopra, and P. Hanninen. “Time resolved fluorescence-based assay for rapid detection of Escherichia coli”. Anal Biochem, Vol 470, pp 1-6 (2015). Available online 16 Sept 2014.

3. P. A. Mosier-Boss, S. H. Lieberman, J. M. Andrews, F. L. Rohwer, L. E. Wegley, and M. Breitbart, “Use of Fluorescently Labeled Phage in the Detection and Identification of Bacterial Spores”, Appl. Spec., Vol. 57, Issue 9, pp. 1138-1144 (2003).

4. R. Edgar, M. McKinstry, J. Hwang, A. B. Oppenheim, R. A. Fekete, G. Giulian, C. Merril, K. Nagashima, and S. Adhya. “High-sensitivity bacterial detection using biotin-tagged phage and quantum-dot nanocomplexes”, PNAS, Vol. 103, Issue 13, pp 4841-4845 (2006).

5. S. Hagens and M. J. Loessner, “Application of bacteriophages for detection and control of foodborne pathogens”, Appl Microbiol Biotechnol, Vol. 76, pp 513-519 (2007).

KEYWORDS: synthetic biology, phage, austere environmental detection, biological detection, chemical detection

TPOC-1: Patricia Buckley
Phone: 410-436-5944
Email: patricia.buckley@us.army.mil